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FILAMENT DISAPPEARANCES

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INTRODUCTION

The phenomenon of the sudden filament disappearance (Disparition Brusque) is a familiar one to observers at H-alpha telescopes. Nevertheless, the importance in Disparition Brusques (DB) continues to grow for several reasons which are cited below. We must report that the Coronal and Prominence Plasmas Workshop was a very "constructive" one--that is, there seemed to be more emphasis on building and maintaining filaments than in destroying them. As a consequence, this sub-group is smaller than most of the others. All the same, progress in this area of filament disappearances seems steady and assured, based on results and programs reported during the Workshop.

THE IMPORTANCE AND INTEREST OF DBs

Disappearing filaments engender interest for two principal reasons. They offer a temptingly simple challenge for various theoretical solar work. DBs also provide a surrogate or marker for still other solar effects whose occurrence is more difficult to discern: the support mechanism for prominences, the changing magnetic fields over a sunspot cycle, and geoeffective coronal mass ejections.

The DB phenomenon seems analogous in many respects to the chromospheric flare process. However, DBs are easier to observe and analyze because they offer a target which pre-exists. Filaments apparently pass from equilibrium into a situation which finds reconnection of magnetic field taking place. Similarly, the pertinent time scales for the DB process are much slower than those in flares, making filament disappearances prime candidates for studies of solar activity/flares.

DBs are important further because in their mode of disappearing, filaments seem to give information (beyond simple feasibility arguments) on how they were originally formed and, especially, on their support mechanism. We must discern what agent intervened (or what process was turned off) when the filament became unstable. The critical thresholds in mass, flux, or field twist that had previously been satisfied may be revealed in eruptions. As a help in answering these questions, Bommier (1986b) offered an interesting paper. Her observations (Bommier et al, 1986a; Leroy et al, 1984) of prominence magnetic fields indicate that tall polar crown filaments appear to be suspended by the Kuperus-Raadu (1974) mechanism, lower-lying active region filaments by the Kippenhahn-Schluter (1957) model. This would be an

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important result to verify because it implies at what altitude and in what configuration the neutral point existed in each case prior to eruption. Surely, the DB or accompanying coronal mass ejection must exhibit different behavior when starting from the K-R or K-S (or from the Hirayama, 1986) configurations.

Information may be available from DBs on the general solar cycle variation of magnetic fields. I note that during the present years of solar cycle minimum, huge filaments may erupt accompanied by only minimal (A-class) soft X-ray emission. In 1980, the same spacecraft instrumentation typically recorded M-class Long Duration Events in soft X-rays with peak intensities 1000 times greater. Is this a function of generally decreased fields, or a predominance during the current phase of the activity cycle of one prominence support mechanism over others?

Finally, in the past few years, solar-terrestrial physicists have grown increasingly aware of DBs (see, for example, Joselyn and McIntosh, 1981). Filament disappearances are now known to be as geophysically important as flares for their geomagnetic storm, ionospheric, and thermospheric heating effects. The reason for this, of course, lies in the coronal mass ejection which invariably accompanies the eruptive (dynamic) DB but is more difficult to detect (Wagner 1984).

It was observations from space that taught us that coronal mass ejections encircle erupting filaments. Space science has also shown us the need to distinguish between true dynamic DBs and thermic DBs which seem to be a temporary heating of the filament to EUV temperatures--not really what had been classically regarded as an eruptive disappearance. Lastly, the advantage of space observations is also apparent in their ability to reveal in soft X-rays the magnetic arches which exist with and after a DB.

Most of the papers in this group use data taken from space. When the American space science program is re-established, we expect that many more of the questions posed here will be answered.

WORKSHOP CONTRIBUTIONS TO DB UNDERSTANDING

Coronal and Prominence Plasmas workshop participants learned the results of one theoretical investigation and three observational studies concerning prominence disappearances. Mouradian, Martres, and Soru-Escaut (1986) provided new details on Disparition Brusques of the thermic type (DBt). With data from Skylab, these workers report that filaments fade and reappear in neutral hydrogen spectral lines in as little as 30 minutes. This could be an important result for prominence formation theory. The heat flux necessary to accomplish this is apparently very high. Certain segments of the filaments were seen to pass through the cycle of recombination-ionization-recombination four times in as many days. Heating appears to progress from the outside of the prominence to the inside.

Malherbe and Forbes (1986) offer work which suggests that extreme temperatures (not unlike those of a flare) in the vicinity of a prominence can cause the prominence to go unstable and disappear. These investigators consider wave, Joule, viscous, and conduction modes of energy transfer to occur in addition to radiative in affecting the target filament.

The trigger mechanism for dynamic Disparition Brusques (DBd) is not well understood currently. Simon, Gesztelyi, Schmieder, and Mein (1986) provided evidence that reconfiguration of magnetic field on a small scale can trigger filament activations. Examples include a case wherein two pores (manifestations of emerging flux knots) move together, leading to the destabilization of a filament and the start of a two-ribbon flare. Another filament activation was marked by the birth of a new pore very close to the filament which was subsequently seen to twist. These authors were of the opinion that such pore-destabilizations are a common feature of the DBd.

Kopp and Poletto (1986) are using the Altschuler-Newkirk (1969) method on line-of-sight magnetic field data over a limited region of the sun (the data are assumed to repeat over the rest of the solar surface). They calculate the 3-dimensional potential field topology in the corona over the location of flares and DBs which are presumed to undergo reconnection processes. Work is in progress to map the coronal field at the time of the 21 May 1980 flare, after which high X-ray arches were observed by the HXIS experiment on the NASA Solar Maximum Mission spacecraft. Results of the calculations will be compared to the observed arches to determine if the post-event coronal field seems to have relaxed to a potential-like configuration. Another interesting comparison will be the estimate of energy represented in the arch formation to the observed thermal energy of the arch. Kopp and Poletto also hope to determine whether the arches represent reconnection at high altitude or simply disconnected loops.

The evolution of a filament through a sequence of magnetostatic equilibria, non-equilibrium phase, and finally eruption as the line current through the filament builds up, can be traced by Kuin and Martens (1986) with their addition of precise energy balance equations to those of force balance. Footpoint field motions increase fields in the filament and simultaneously electric current. The filament rises to find a new equilibrium. Eventually, no more equilibria configurations exist which will allow a balance of forces. The filament undergoes a dynamic disappearance and at the same time induces large currents in the neutral sheet far below the erupting filament. These lead to H-alpha flaring action below the eruptive. These authors suggest various data sets which, if obtained, would test this DB-flare model.

More extensive discussions of recent work on disappearing filaments may be found in the excellent reviews by Tandberg-Hanssen (1974) and Martin (1980).

FUTURE DIRECTIONS

The Workshop group on disappearing filaments discussed a number of interesting questions for further consideration or work. Of very basic importance for constraining models that address filament support and/or eruption is an increase in our knowledge of coronal magnetic field configurations. Thus, the analytic work which compares calculated potential configurations to observations of field structure should be supported (perhaps by offers of computer time). Likewise, an X-ray instrument such as that on the Japanese HESP satellite or planned U.S. soft X-ray telescopes will provide valuable data for this purpose. These data are unobtainable from ground-based observatories. In addition, such instruments promise to yield time-dependent studies of magnetic field evolution. Our present solar "atmospheric sounding" is limited to the very modest range of heights represented by visible wavelength magnetograms and the tracings of white light pores.

It would help us to describe why a filament's "disparition brusque" occurs if we could state with certitude that magnetic fields along a neutral line cannot erupt without the presence of a filament. Are there such things as spontaneous erupting non-prominences, or are these simply called "flares"?

Finally, much can probably be learned from disappearing filaments about the way they are originally formed and supported. For example, it was not clear to the group that the Kippenhahn-Schluter mechanism, for the suspension of low-lying active region filaments, can permit thermic DBs. Yet, the DBt seems to be an active region event, rather than a high latitude phenomenon. Also, progress would be made if the process of the unwinding of a DBd were better understood. Is unwinding more common in active region filament eruptions than in polar, high altitude filament eruptions? Is this unwinding process related to the respective support mechanisms?

The disappearing filament group looks forward to answers to at least some of these problems. The group hopes it served to aid the formulation of these questions if not their resolution.

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